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"INVESTIGATION OF THE MODELS USED AND THE ACCURACY OF EXCHANGE RATE FORECASTING"

DIPESH KEVAL MEHTA

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ABSTRACT

Currency forecasting has been the most difficult task in today's world. Hence, this study compares the forecasting accuracy predicted on the basis of various fundamental and technical models of exchange rate determination. The dissertation is divided into two parts where the first part states the fundamental models which determines the long term determinants of exchange rates and technical models which determines the short run determinants in exchange rate determination where as the second half of the dissertation comments upon the accuracy and inaccuracy of exchange rate forecasting by comparing the actual values and the forecasted exchange rate values. This study also provides some awareness to all the forecasters about some of the financial and non financial factors affecting the exchange rates so as to make appropriate forecasting decisions for the future.

ACKNOWLEDGMENT

It is indeed a matter of great pleasure and pride to be able to present this project on "**MODELS AND ACCURACY OF EXCHANGE RATE FORECASTING**"

Although bringing this Project to its final form was a long and difficult task, there were many pleasures on the way, the knowledge gained while making this project has been of immense help in culminating hands on knowledge.

During the perseverance of this project, I was generously supported by several people. There are a few people, whose names, if not mentioned, would be inconsiderate on my part.

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1. INTRODUCTION

INTRODUCTION TO CURRENCY FORECASTING

Currency forecasting simply means to predict future currency moments well in advance. It has become the one of the most challenging task in today's world. It has received a lot of importance by various economists and financial practitioners in recent years. What is going to happen next?, Which direction will the currency go?, What path will this currency take in its long, medium and short run, are some of the important aspects of currency forecasting process. Trillion of dollars are traded every day in this foreign exchange market alone and today this financial market is the busiest markets of the world. In this competitive and challenging market various analysts, investors and speculative traders' needs tools in order to analyze and make take appropriate decisions. Traders, investment banks, financial institutions, analysts, companies and various private individuals predict the future movement of the financial markets before making any investment decisions. Recent economic and financial news, market reports and strategies, prioritizing opinions are some of the parameters; investors will look for before making any decisions. It also includes long run advantages of fundamental- based exchange rate models with the shorter-run advantages of technical-based exchange rate models" (M. Rosenberg, 1996). "In future, predicting exchange rates will be the most important aspect due to its high increase in tradable volume every day, it's ever increasing demand and improving individual country's economy as compared to other economies of the

world. Investors and many others predicts that the currency will react in the same way as it reacted before and match the past trend with the current one. This type of analyses is called as technical analyses of predicting future currency. But it is not the case always. There are various fundamental parameters such as inflation, interest rates etc which also affects the future movements of currency. The exchange rate market have been highly volatile since the start of floating rate regime and have always broken the intrinsic equilibrium levels of empirical fundamental models such as PPP (purchasing power parity), Balance of payment model and monetary model to determine future exchange rates. According to Dalrymple (1987), Klein (1987) and Linneman (1984) more than fundamental or technical judgement, it is the human judgement which plays a significant role in most of the practical currency forecasting situation. Now let us study in deep how these above models help in forecasting exchange rates.

1.2 OBJECTIVE OF THE STUDY

Getting the currency right" has become the most important objective for the entire market participant around the world. The purpose of this currency forecasting is to provide international investors, corporation treasurer, and policymakers with a better understanding of the fundamental and technical forces driving exchange rates over time. Moreover it also combines fundamental and technical methods of forecasting and will assist the users to formulate and investigate future currency more effectively.

1.3 OUTLINE OF THE STUDY

Chapter one covers the basic introduction of exchange rate forecasting and the motivation of the study. It also includes some of the basic reason of conducting forecasting and who is finally benefited from this forecasting techniques. Chapter two starts with a brief introduction about what are the approaches to determine or forecast exchange rates. Later in the chapter the fundamental and technical approaches in exchange rate determination are explained in detail. Purchasing power parity, Purchasing Power Parity, Balance of Payment Flow, Model, Mundell-Fleming Model, Monetary Models, Real Interest Differential Model are some of the fundamental models explained in detail as how exchange rate can be determined with the help of the these models. Similarly, Moving averages and Charting are the technical models which are some of the short term forecasting are explained in detail. The later half of the thesis that is from chapter three explains the methodology used in finding data the error term caused due to differences in the actual and the forecasted exchange rates and chapter four explains the financial and the non financial reasons for the inaccuracy of forecasted data. Last the tail sections summarizes all the work done and let us find out the conclusion regarding the same.

2. LITERATURE REVIEW

2.1 OVERVIEW OF THE METHODS USED IN EXCHANGE RATE DETERMINATION

Forecasting exchange rates has become one of the most difficult tasks in today's world. There is millions of foreign exchange transactions carried out on the daily basis. Many of this transaction are settled in the future and are worth billions of dollars. Hence, forecasting exchange rates have become very important in order to evaluate cash flows involved in international transactions and also help in evaluating risk involved and profits generated in the near future. According to Madura (2006), forecasting techniques are classified into four type's namely technical methods, fundamental techniques, mixed based methods, and mixed technique which is a combination of three techniques. Out of these four techniques technical method and fundamental techniques are the most widely used techniques. Technical forecasting is based on historical exchange rate data and focuses on short run forecasting. It provides some precision and hence it cannot forecast distant future. Fundamental forecasting is based on several factors such as inflation rate, interest rate income level changes in government control and the expectation of future exchange rates (Madura 2006). Now let us study in detail the 'fundamental' and the 'technical' methods of exchange rate forecasting.

2.2 FUNDAMENTAL APPROACH IN EXCHANGE RATE DETERMINATION

2.2.1 Introduction

The fundamental approach or fundamental analysis is one of the most common approaches in determining future exchange rates. Literature has given emphasis on various macroeconomic variables such as interest rates, trade balance, inflation rates, consumption level, indexes, production, GDP, unemployment, balance of payments, and economic growth. Numerous number of fundamental models have been developed using these macroeconomic variables. For example; Purchasing power parity, Monetary Models, Real interest rate differential model etc. which is fairly straight forward in determining future exchange rates. Fundamental approach is mainly based on structural models of currency forecasting which are commonly known as equilibrium models. These structural models are a mixture of art and science and takes into account experience of forecasters and special characteristic of data. Various practitioners use fundamental analysis to analyse equilibrium exchange rates which are used to generate future trading signals. This trading signal helps in analysing the forecasted exchange rate and the actual rate prevailing in the market. The practitioner then finds out the reason for the differences in the actual rate and the forecasted rate whether it is due to mispricing or is it due to the heightened risk premium. The mispricing difference indicates a signal of buy or sell of a given currency. Moreover fundamental approach includes three steps in determining future exchange rates. They are (1) Estimating the model, (2) Estimating the future parameters and lastly using the model to develop forecast.

2.2.2 Fundamental Models

There are several fundamental models in order to determine spot and the future exchange rates. Interest rates, inflation rates, economic growth, country's GDP etc are some of the common and important parameters used in all the fundamental models in determining exchange rates. Some of the important fundamental models can be explained in detail as follows:

2.2.2.1 PURCHASING POWER PARITY

Introduction

Purchasing power parity (PPP) is one of the simplest forms of fundamental method of determining exchange rates. It is mainly classified into two types absolute PPP and relative PPP. There is large number of presumptions to be considered while determining exchange rates with absolute PPP and hence many economist and empirical surveys have rejected absolute PPP. A deviation from absolute PPP is called the relative PPP. "Relative PPP is equivalent to real exchange rate being constant" (Rosenberg M). The short run performances of both this PPP are empirically rejected but some empirical studies have found relative PPP to be correct in long run. We have previously seen the value of PPP in explaining exchange rate changes. Its application in currency forecasting is straightforward.

The theory of purchasing power parity was developed by a Swedish economist Gustav Cassel in early 1920's in order to forecast and equalize the purchasing power of long-term exchange rate movements of two currencies. It is one of the

oldest and the most widely used approach by various economists. According to Rosenberg (1996), currency forecasting is based on the law of one price i.e the value of the currency depends upon the ratio of the domestic prices and the prices abroad. It not only takes into account the nominal gross domestic product of different countries but also compares the relative cost of living and the inflation rates of different countries. For example if we consider the currencies of India (INR) and UK (GBP), the value of INR (Rs.)/ GBP (£) is determined by the ratio Indian price levels (P_I) relative to the UK price levels (P_{UK}).

$$\text{Rs/£} = P_I / P_{UK}$$

Suppose the cost of producing a product in India is Rs 8000 and the cost of purchasing the same product in UK is £ 100, the exchange rate that equalizes the purchasing power cost is:

$$\text{Rs/£} = P_I / P_{UK} = \text{Rs } 8000/£ 100 = 80$$

Now, if the actual exchange rate is above or below the equilibrium PPP level their will be an arbitrage opportunity and people would have something called as free lunch.

How well it has performed in the past

There has been a huge debate upon the success of PPP in the past. Volumes of literature and various evidences suggests that PPP has performed significantly well in the short and the medium run as compared to the long run. According to the findings and investigations conducted by Frenkel (1978, 1980) and De Grauwe, Janssens, and Leliaert (1985) PPP doctrine was valid during the floating rate periods of 1920s and 1970s. PPP performed much better in 1920s as compared to 1970s. The reasons for the poor performance of PPP in 70s were due to major calamities such as oil price shocks of 1973 and 1979, unequal productivity growth, major changes in national fiscal policies, and scarcity in various commodities and it lead to greater unpredictability in exchange rates in the 1970s. This broke the link between exchange rate changes and national price changes. Whereas in the year of 1920s, most shocks were of monitory nature, such as inflation disturbances (hyper inflation episode in Germany), and thus PPP was found to be generally valid. Recently PPP has focused on the real and the nominal exchange rates. It checks whether it follows a mean reverting process or a random walk process. If it follows a mean reverting process it can perform good in the long run proposition but if it exhibits a random walk the outcomes i.e the real exchange rate might not exhibit near to its mean values and possibly give significant departures.

For example, let the real US$/GBP£ exchange rate be defined as the nominal US$/GBP£ exchange rate multiplied by the ratio of the US-to-the-UK price level:

$$\text{Real US\$/GBP£} = \text{Nominal US\$/GBP£} * P_{US} / P_{UK}$$

If PPP holds true, the real US$/GBP£ exchange rate should be constant over the period of time. This means the changes in relative prices are balanced by the changes in the nominal exchange rates and the real exchange rate will be stable over the period of time in the long run. The real exchange rate can move either side of a constant long – run equilibrium level, if the real exchange rate reverts near to its men value in the long run. Mean reversion or a random walk has always been a point of research amongst various economists and most of them concluded that PPP hypothesis should be rejected as most of the times the real exchange rate followed a random walk.

Relationship between PPP and exchange rate policy

Purchasing power parity has always been remembered while discussing various exchange rate policies. There appears to be a growing sentiment to return to a more managed exchange rate system-either in the form of a rigid fixed exchange rate system or a slightly more flexible target zone exchange rate system. Proponents such as McKinnon (leading advocate to a PPP based fixed exchange rate system) believes that PPP can act as an anchor or foundation for a new exchange rate system. In his proposal he states that USA, Germany, and Japan should institute a fixed exchange rate system and PPP as a nominal anchor. Now the monetary policies in these three countries would adjust to fix the yen/$ and DM/$ rates around their estimated PPP levels as the people of this countries would pay and receive the same prices of all tradable goods and hence, roughly would have the same purchasing power. The central banks of these countries i.e

Federal Reserve, Bundesbank, and Bank of Japan would surrender their autonomy and will constitute one effective common currency amongst them in order to preserve global price stability and promote economic growth.

Problems in calculating PPP

Empirical evidence shows that there has emerged various problem in exchange rates determination using PPP hypothesis. Accuracy of using PPP tool has always been a point of discussion in the international economics. The main problem amongst the economist is that there exists infinite number of different ways to determine exchange rate using PPP tool where each methods gives out different values and interpretations of its being overvalued and undervalued also differs. While assessing relative prices i.e taking to account which economic price indicators GDP deflators, export price index, consumer price index, wholesale price index or wages or some other price index has always been a point of issue amongst the economist. The following table shows the PPP calculations for DM/US$ and it is seen that exchange rate vary considerably due to the use of different relative price indexes.(Michael Rosenberg, 1996)

Alternative Price Indices	Alternative Base Periods		
	1973	*1980*	*1990*
Consumer Prices	1.66	1.62	1.51
Producer Prices	1.88	1.90	1.52
Wages	2.87	2.35	1.67
Export Prices	1.80	1.88	1.51

TABLE 1: ALTERNATIVE PRICE INDICES

PPP Formula for the above analysis: $\frac{P^{G}_{1993} / P^{G}_{Base}}{P^{US}_{1993} / P^{US}_{Base}} * DM/US\$_{Base} = PPP^{DM/US\$1993}$

The second major problem in calculating PPP is selecting the appropriate base year because it is said that the changes in the price level has always been with respect to some base year. Again if different base years are taken into account by different economist there will exits different outcomes resulting into overvaluation and undervaluation of currency. According to Michael Rosenberg the best appropriate base year that is to be taken into account is the year where both the countries attained a zero or almost zero current account balance i.e in their nearest state of equilibrium.

The Adjustment Process

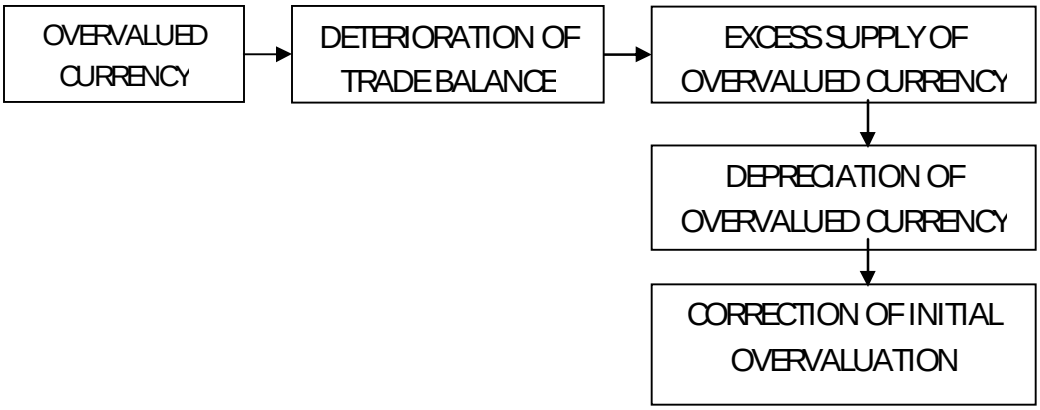

Figure 1: PPP Adjustment Process (Rosenberg, M., 1996)

There can be an overvaluation of currency due to various different interpretations and different criteria's taken into account by various economists such as different base years or different indexes which will directly affects the prices of domestic goods in the foreign market and thus reducing the demand for domestic goods in the foreign market. This will cause a deficit in the balance of trade in the domestic country and currency will be overvalued whereas there will be a surplus in the foreign country and its currency will be undervalued. Now the demand in foreign market for its home undervalued currency will rise causing it to push upwards toward the equilibrium and on the other hand the demand for the domestic currency in the foreign market will fall causing it to push downwards. Both the currencies would be pushed back toward the equilibrium PPP levels and again the demand for the domestic currency in the foreign market will began to rise. Thus, economic factors have leaded the currency back towards its PPP levels after the initial period of being overvalued and undervalued.

The Modern Simple Formula of PPP

Purchasing power parity can also determine future exchange rates with the help of the current spot exchange rate prevailing in the market and the intended future inflation rates of both the domestic and foreign the countries. It is given as:

$$\text{Expected Future Spot Rate} = \text{Current Spot Rate} * \frac{(1+\text{Foreign Inflation Rate})}{(1+\text{Home Inflation Rate})}$$

Conclusion

As mentioned in the outset, PPP is one the most important model in determination of exchange rate and indirectly helps in taking various important future decisions. PPP has the richest historical tradition amongst all the other fundamental models. It is also considered as a important long term tool in making various investment strategies and making policy deliberations. On the other hand PPP is also filled with some errors and could cause funds managers incur huge losses and wrong policy decisions could result in economic and structural differences amongst competing nations. Let us now try and work out whether other relevant fundamental models can help in understanding and determining exchange rates.

2.2.2.2 Balance of Payments Flow Model

Introduction

What is going to happen next?, Which direction will the currency go?, What path will the currency take in its long and medium run, are some of the important aspects of currency forecasting process. Though purchasing power parity is widely used model, it has its own limitations attached to it. According to Michael Rosenberg there were large deviations from the actual exchange rate using PPP and thus was inappropriate using it in the short and medium run. Many economists considered balance of payment model as one of the appropriate alternative to the purchasing power parity model. This BOP flow model was developed by John Robinson, Fritz Machlup and Gottfried Haberler in 1930s and 1940s. This framework helps in determining exchange rates in the long-run. It came into existence before the portfolio and monetary approaches to exchange rates came into existence (1970s). It is a way of analyzing and monitoring the flow of demand and supply of foreign currency in the foreign market. Since the demand and supply of currencies are directly related to capital and current account balances i.e the balance of payments, the changes in the exchange rate are directly explained by the changes in the balance of payments flows. The net inflow and outflow of foreign exchange in the current account and the capital account balances helps determining the equilibrium exchange rate. This is called the BOP flow framework.

The Flow Model in Determining Exchange rates:

The BOP model developed by John Robinson, Fritz Machlup and Gottfried Haberler focuses mainly on the role of trade flows and capital flows of exchange rate determination. Initially the main focus was only on the trade flows and hence, it was called as balance of trade model (BOT). Capital flows were also added to the trade flows in order to determine exchange rates and then it was called as balance of payment flow model (BOP). Let just see with an example and diagram how initially BOT model used to determine exchange rates. Consider the following diagram:

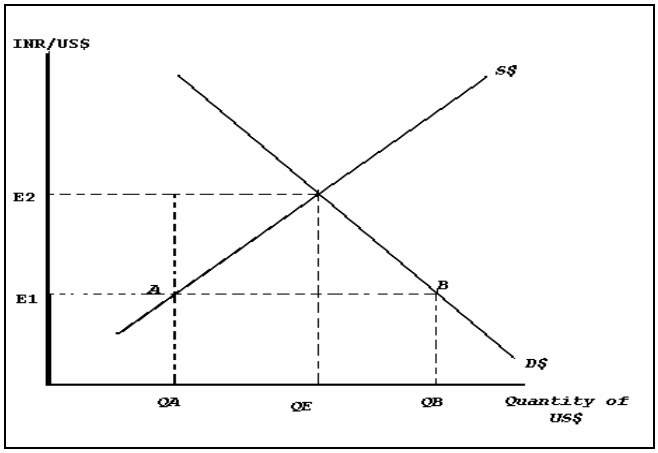

FIGURE 2: BOT MODEL

The above diagram shows the balance of trade (BOT) model of determining equilibrium exchange rate of Indian rupees and US dollar ($) The X- axis represents the quantity of US$ in the market per interval of time where as the Y-axis represents the Indian rupees/US dollar exchange rates. Now the demand for dollar $(D_{\$})$ will increase with the Indian demand for US goods as Indians will first acquire dollars in order to make payments for US goods. Similarly, supply of

dollar $(S_{\$})$ will also rise with the demand of Indian goods by the US residents as they will have to exchange dollars for Indian rupees. Thus, this demand and supply flow of US dollar will result into balance of trade between India and US and the point of intersection which is called as equilibrium will determine the exchange rate (E_2) between theses two countries. When capital flow adjustments are done in this BOT model then it is called as balance of payment model (BOP). It is shown as:

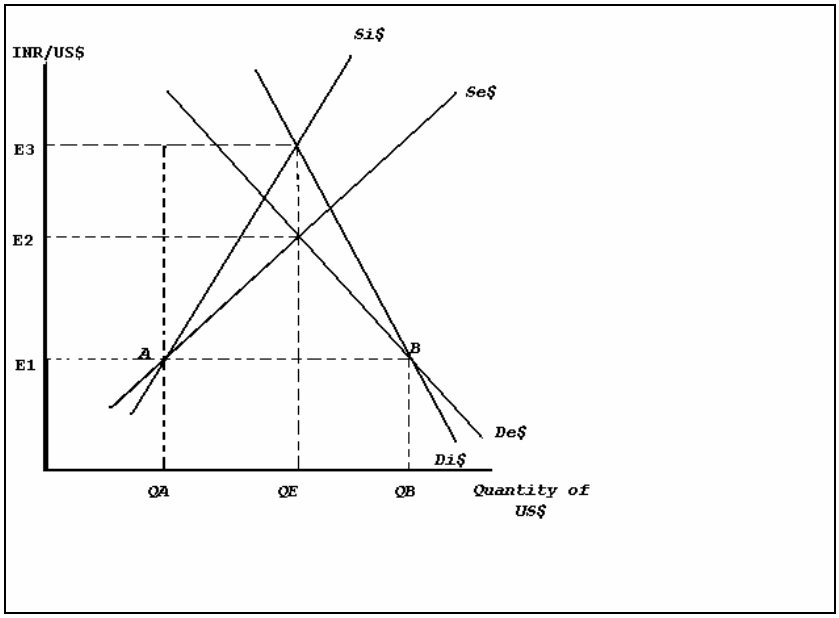

FIGURE 3: BOP MODEL

In the above diagram the E3 and E2 are determined due to adjustment of trade deficits and surplus from the capital. Hence, it is called as BOP flow Model.

Mathematical Formulation

The BOP flow model can also be expressed in simple algebraic formulae:

$$e = b_1(Y - Y^*) - b_2(i - i^*) + b_3(\bar{e} - e)$$

Where 'Y*' is the economic growth of the foreign country and the single 'Y' denotes the growth of the home country. (Y-Y*) denotes the net growth of the home country. Similarly, 'i' and 'i*' denotes the interest rates of home and foreign countries respectively and (i-i*) is the net difference in the interest rate between both the countries. $(\bar{e} - e)$ is the difference between the future ($\bar{e}$) and the spot (e) exchange rates. The above equation simply state that rise in the economic activities will result in the depreciation of the home currency where as a rise in the domestic interest rate will appreciate domestic currency and thus increasing the value of the home currency.

Conclusion

We have now seen how the surplus and deficit adjustment in the balance of trade leads to balance of payment flow model and the equilibrium helps in determining exchange rates. Moreover this model will also help in forecasting the equilibrium between any two countries if the imports and export of those countries can be analyzed. But the BOP framework was heavily criticized in 1970s as it mainly focused only on the flows and not on stocks and other financial assets. Moreover, it only focused on trade flows and where as modern models also has taken into consideration the role of capitals flows in determining exchange rates.

Presently the BOP is not much used by many economists but it is still being considered during international investment strategies.

2.2.2.4 THE MUNDELL FLEMING MODEL

Introduction

The existence of this model is due to the pioneering work of Robert Mundell (1963) and J. Marcus Fleming (1962). It is the extension of the IS-LM model of exchange rate determination. Where 'IS' stands for Investments and Saving Equilibrium and 'LM' stands for Liquidity Preference and Monetary Supply Equilibrium. The Mundell-Fleming Model (M-F) is a short run exchange rate forecasting model and mainly focuses on the impact of certain policies and policy mix on interest rates and exchange rates determination. For example, dollar appreciation in 1980s which was due to changes in the monetary policy and the expansion of fiscal policy in the United States and the Deutsche mark appreciation in early 1990s due to the policy mix would have been predicted if Mundell-Fleming Model was used to determine future exchange rates. Today this model is widely taken into consideration by students studying the role of fiscal and monetary policies. Though it is mainly used in stabilizing the policies in the open economies, it also is appropriate in exchange rate determination. This model also takes into consideration the role of capital mobility because it indirectly relates in determining exchange rates because is directly related in determining the effectiveness of fiscal and monetary policies in one's economy. For example expansion of monetary policy will lead to depreciation of domestic

currency and decline in the interest rates which will result in more supply of capital and thus will weaken the domestic currency. But it is vise-versa in respect to fiscal policy. It will appreciate the value of domestic currency due to rise in interest rates and less supply of capital flow in the domestic country. The IS-LM model stats with considering three markets namely goods money and assets and in the M-F model the balance of international payments is one more aspect with is taken into consideration.

The following is the equation of the goods market equilibrium as the IS curve:

$$Y = C + I + G + (X - M)$$

Where Y is the domestic national income, C denotes consumption, I is the investments, G are the government spending and (X-M) denotes exports minus the imports which is the increasing function of foreign and domestic and national income and decreasing function of real exchange rate. Where real exchange rate is defined as:

$$q = \frac{SP^*}{P}$$

Where *S* is the nominal exchange rate; *P, P** denote, respectively, domestic and foreign prices.

"Next we define the money market equilibrium through LM curve. Let $M^d/P = L(Y,i)$ represent money demand, which is an increasing function of domestic

income and decreasing function of the interest rate, and M^S represent money supply". The money market equilibrium condition can be expressed as:

$$M^s / P = L(Y, i)$$

(Michael Rosenberg 1996)

Finally, the external equilibrium is denoted by the BP equation: *BP = CA + KA = 0*

Where Current account $CA = PX - SP * M$ and Capital account $KA = K(i - i^* - \Delta s^e)$

How Changes in Monetary Policy Impacts Exchange Rates (Mundell – Fleming Model)

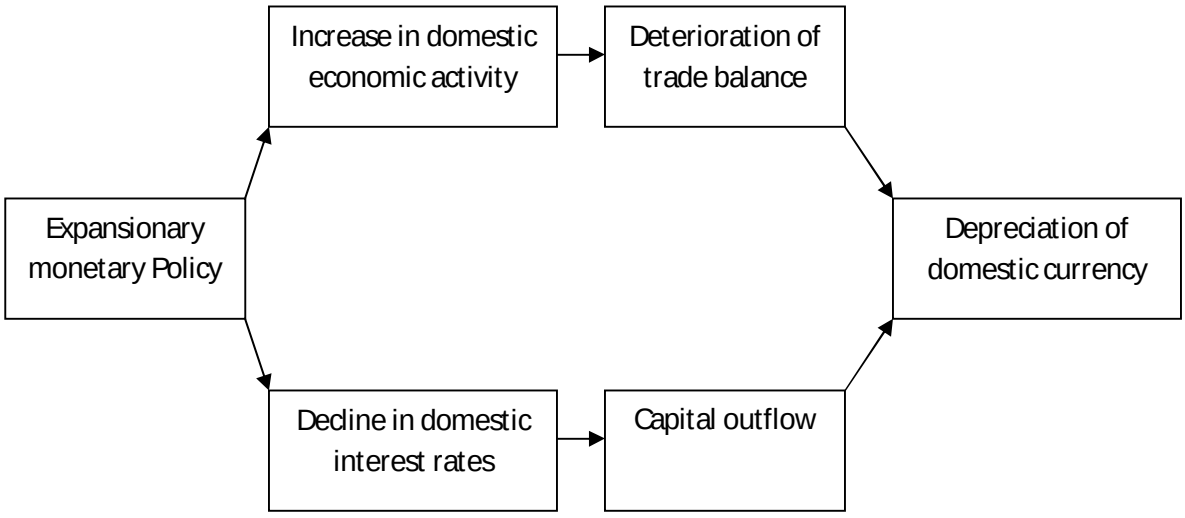

FIGURE 4: MONETARY POLICY IMPACT ON EXCHANGE RATES

The above diagram states how expansionary monetary policy leads to depreciation of domestic currency. Moreover, according to Mishkin (1996) there exist mainly kinds of monetary policy they are and they have different impacts:

1) *Interest rate channel* – easier monetary policy will lead to *lower short-term interest rates* and *investment spending will rise*.
2) *Bank lending channel* – expansionary monetary policy will lead to *increased bank loans* and *investment spending will rise*.
3) *Exchange rate channel* – easy monetary policy will lead to a *depreciation* of the exchange rate which will contribute to a *rise in net exports*.
4) *Inflation expectations* – a *higher expected inflation* rate will *lower the real short-term interest rate*.
5) *Wealth effect channel* – easier monetary policy will *raise equity prices* and *real estate values* with will increase net wealth and *boost consumption*.

Conclusion

"Trilemma" is one of the limitations of this model which states that capital mobility, monetary policy independence and a fixed exchange rate regime cannot be achieved simultaneously. Moreover it further stated that achieving capital mobility in a fixed exchange rate system for a country's monetary policy independence is not sustainable. Along with forecasting exchange rates it also forecasts the correlation of monetary supply and exchange rates level in the long run concluding that monetary policy play a trivial role. Fiscal discipline, inflation and balance of payment can lead to "devaluation" if they are not managed properly or if the asset market produces a self-fulfilling bubble. Finally, the impact of devaluation on the improvement of the current account may be weakened if an economy is heavily reliant on the re-export processing industry.

2.2.2.4 Monetary Exchange Rate Model

Introduction

There have been various significant impacts on the exchange rates due to changes in the monetary policies in the past. For example during the carter administration, the simple monetary policies implemented by the US government let to the fall in the dollar in 1977-78 and the tightening of the monetary policies again in the early 1980s sharply appreciated the US dollar. In fact, the exchange rates adjust itself with the changes in the policies by the central bank of any country. These impacts on exchange rates with the changes in the monetary policies started after the end of the Bretton Woods era (1970s). The Mundell-Fleming model showed that changes in the monetary policies lead in weakening the value of domestic currency due to more supply of capital and decline in the interest rates in the economy with an assumption that prices would be fixed in the short-run. Where as, the monetary approach in determining exchange rates is more classical and works with the assumption that price will be flexible in the short-run. Hence it is also called as the flexible- price monetary model. The supply and demand for money being the primary determinants of the changes in the inflation trends, the monetary approach states that the country's monetary policies determines the short and long run path taken by inflation rates and the exchange rates. The flexible price-monetary model explains the effect of supply and demand for money on the exchange rate determination.

In order to determine exchange rate using thos model consider the following equations which are expressed in terms of logarithms except for the interest rates. This model includes three blocks:

The first block includes the money market equilibrium equation:

$$m_t - p_t = -\eta i_t + \phi y_t$$

Where p is the log price level, I is the nominal interest rate, Y is the log of real output and m is the log of money supply.

The second block is purchasing power parity. Let e be the log of the nominal exchange rate, defined as the price of foreign currency in terms of home currency; p*,p denote the log of the world foreign currency price of the goods basket and the log of the home currency price level. The purchasing power parity in log terms is:

$$e_t = p_t - p_t *$$

The third block is uncovered interest parity expressed in terms of log and is given as: $i_t = i_t * + E_t e_{t+1} - e_t$

Substituting the equations of the second and the third block into the first block gives:

$$e_t = \frac{1}{1+\eta} \sum_{s=t}^{\infty} \left(\frac{\eta}{1+\eta} \right)^{s-t} E_t \left\{ m_s - \phi y_s + \eta i_t^* - p_s^* \right\}$$

(Rosenberg, M., 1996)

Given money supply, foreign interest rate and price, this simple monetary model demonstrates that the exchange rate depends on both current values as well as expected future values of related variables; that an increase in the domestic money supply and foreign interest rate raises both the domestic price level and nominal exchange rate level; and that changes in real domestic income and the foreign price level have a negative effect on the domestic level and nominal interest rate.

Conclusion and Criticism

The monetary policy only offers a partial picture of the forces determining exchange rates. Exchange rates exchange rates are determined in a broad general equilibrium framework where not only the supplies of and demands for national monies are important but the supply of and the demand for goods and securities are important as well.

2.2.2.5 Real Interest Rates Differential Model

Introduction

The monetary policy was at its early success in determining flexible exchanges rates (Frenkel, 1976; Bilson, 1978), but later its performance in predicting exchange rates started to decline. Dornbusch (1976) suggested that price inertia can be useful in determining large exchange rate movements. And finally Frankel (1979), estimated with a reduced form Dornbusch model called a “real-interest

rate differential model". Real interest rate is a result of the difference between the nominal interest rate and the inflation. Interest rates play a vital role in determining exchange rates in all the fundamental models. It serves as a link between the changes in the economic factors and the changes in the exchange rates. For example, the impact of monetary policy on exchanges rates in the M-F model operates mainly through interest rates channel. That is, the expansionary monetary policy leads to adequate supply of money and lowering the domestic interest rates, resulting into depreciation of domestic currency. Where as changes in fiscal policies leads to less supply of money causing the interest rates to rise and thus resulting into appreciation of domestic currency. The rise in the dollar prices in the in the early 1980s led to the widening of the US/Foreign countries interest rate differentials and attracted huge cash flows and the later half of 1980s again led to the narrowing of those differential. Let us now analyze the key determinants and the role that real exchange rates play in determination of exchange rates. Due to high increase in the free flow of capital across the globe, it will also help in explaining the importance of current account balances and the sensitivity of exchange rate to real versus nominal interest rates, long verses short term interest rates and transitory verses persistent changes in interest rates.

The model (Formula)

According to Michael Rosenberg, real interest rate differential model is based on the following two assumptions: Firstly is assumed that uncovered interest parity $\{1+i_t/1+i_t* = E(S_{t+1}/S_t)\}$ holds and secondly the real exchange rates will adjust gradually to its long run purchasing power parity level. The formulae in calculating the rate differential between the domestic and the foreign country is given as:

$$q_n^e = n(r - r*)$$

The above equation states the market expected change in the real exchange rate over a 'n' number of years equals to the differential in the real interest rates in the foreign and the domestic country.

Where; q_n^e is the expected real exchange rate for n number of years and $(r - r*)$ is the difference between the rate differential rates between the domestic country and the foreign country. (*) denotes the foreign country. Moreover, the 'r' which is the real interest rate of the domestic country is derived from the difference between the nominal interest rates and the relative inflation rate $(i - p^e)$ of the domestic currency and $r*$= $(i* - p^e*)$ for the foreign country. Hence the above equation states the change in the real exchange rate over 'n' number of years is equal to the difference between the real interest rate of the domestic and the foreign countries.

Empirical evidence

There has been a big controversy among various economists of whether any correlation exists between the changes in the real interest rate differentials and the changes in the real exchanges rates. Most studies concluded that there exists a strong relation on the contrary many fail to explain any long-run relationship. Various studies of Shafer and Loopesko (1983), Sach (1985), and Hooper (1984) estimated the impact that changes the real interest rate differentials in the long run on the real value of dollar during the 1980 decade. They stated that, in all cases except for the dollar/pound exchange rate, the coefficients were correctly signed and there exists a correlation on the real interest rate differential and exchange rates in the long run. The coefficient lies between the averages of 2.0 and 6.0 which suggest that there is a strong relationship and the rises in dollar value was due to the rise in the long term interest rates in US. Coe and Golub (1986) also conducted studies of 18 OPEC countries to find the impact that changes the real interest rate differentials in the long run on bilateral exchange rates. They concluded that though this differential model is proved to be appropriate in most of the model but is not valid in all cases i.e Australia, Canada, Spain and UK. They further stated that with relatively low R-square very low amount of variation is explained by this interest rate differential model. Investigations by Campbell and Clarida also found that the changes in US/Foreign real interest rate differential did not impact much on the rise and fall in dollar prices in 1980s. Modern researchers use uses co-integration test which examines whether any stationary relationship exits

between two variables and one of them is Meese and Rogoff (1988) who investigated the monthly changes from 1974 to 1985 and reported two non co-integrated variables between the real exchange rates and the real interest rate differential. Moreover, the extended study of Meese and Rogoff (1988) conducted by Coughlin and Koedijk (1990) stated that the real interest rate differential and the changes in the value of dollar were indeed co-integrated. Thus, finally if a relationship exist between real interest rate differential and the real exchange rate of the domestic and the foreign country it is only in the long run and not in the short or medium run.

2.3 Technical Approach to Currency Forecasting

2.3.1 Introduction

Technical approach and technical analysis is the antithesis of fundamental approach for the determination of exchange rates. It existed from the study of financial markets for over a hundreds of years ago and only focuses on smaller sections of the available data. The term 'technical' implies that does not rely on fundamentals (economic factors) and is based only on the concept of past price trends. It is a security analysis for forecasting which involves study of past behaviour of a particular asset in terms of its price, volumes etc and then drawing future conclusions in respect of its magnitude and direction. The main principle of technical analysis is the trend movement i.e the behaviour of the asset in the past and then the same trend can be followed to predict the trend or the asset behaviour in the future. If not much, but traders, fund managers and some of the others uses some technical analysis to make their investment decisions. It is used over the fundamental analysis because it performs much better than them when there is high volatility involved in the exchange rates. It is a method in which it keeps an investor trading along with the trend. Technical approach relies on repetition of specific patterns and positive results imply trading buy and sell signals. The trend following system of technical analysis computes various mathematical computations to identify price trends. The popularity of technical analysis is growing day by day because of high dissatisfaction and poor performance of fundamental models of exchange rate determination. Today it

stands as a distinction to fundamental analysis. Various investors using technical analysis are generally less interested in the fair value of the asset. Inspite they are more concerned about the prices that will be assigned to the asset by the market. Ignoring the actual nature of the financial assets (currency, stocks...etc) it is only based on the charts. It has been proved positively in 56 out of 95 modern studies but has been inconclusive due to various data manipulations. Hence it is regarded as art and not science. Technical analysis is mainly based on two main method i.e charting and trends.

2.3.2 Technical models

2.3.2.1 Charting

Charting is one of the very widely used technical methods of pricing and estimating future currencies. Charts are referred as a series of prices over a specific period of time. Statistically, “charts are also called as time series plots”. Various technicians, technical analysts and chartist make use of these charts and charting techniques to forecast future price movements of various securities. On the charts there is Y axis and X axis which represents price scale and time scale respectively. Though charts are mainly used by technical analyst but it is not restricted only to technical analysis. It is also used by fundamental analysts as; a chart helps them to make and read graphical representations of prices over a period of time, more easily. A graphical historical record makes it easy to spot, the effect of key events on a security's price, its performance over a period of time and whether it is trading near its high, low or in between. There can be

different time frames on which different charts are formed. It can be intra day price charts, or on daily basis or weekly or monthly. These are a result of compression of data. The more the compression of data the more data is displayed. In order to forecast any tradable financial asset analysts usually uses more compressed data so that ore historical information is displayed and future analysis is made easy. For example, to forecast 3 months future rate technical analysts usually use data of three to four months (252 trading days in a year). But shorter the forecast period the less is the compressed data. For long term (1-4 years) prospective analysts use more compressed data i.e more historical price information. Where as now a days both long term and short term charts are used in order to forecast as long term chats can be used to forecast broader prospective using historical data and then daily chats can be zoomed and analyses for short term perspective.

Types of charts

There can be various different types of charts that can be formed with the help of all the historical and current prices of data available of any currency or other financial asset. But the main or the popular methods for displaying price data are:

Bar Chart

It is the most popular charting method where parameters such as the closing price of the currency the high and low of the currency is used to form the chart. The high price and the low price of the currency respectively represents the top

and the bottom values of the vertical bar and the closing price is denoted by the short horizontal line crossing the vertical bar.

It looks somewhat like this:

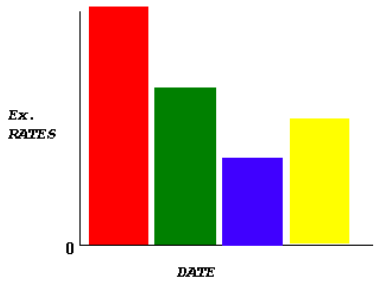

FIGURE 5: HISTOGRAM EXAMPLE

Candlestick Chart

This is also one of the popular methods in order to analyze the historical trend and draw conclusion of the future trend of any financial asset. In this method along with high, low and close, opening price can also be easily be plotted. In this type of chart there are white candlesticks which are formed when the closing price is higher than the opening price and black candlesticks are formed when the closing price is lower than the opening price. the line above and below the opening and the closing price represents the high and the low. It is the best method to find the relationship between the opening price and the closing price. It looks somewhat like this:

FIGURE 6: CANDLEDTICK CHART EXAMPLE

Point and Figure Chart

Unlike the bar chart and the candlestick chart it does take time into consideration and changes only on the basis of asset price movement. There exists a X axis but it does not extend across the chart. It is very simple and it does not take into consideration small changes. Only change which exceeds a specific level is recorded in this type of charting method and thus makes it easier to analyze the resistant and the support levels of and financial asset.

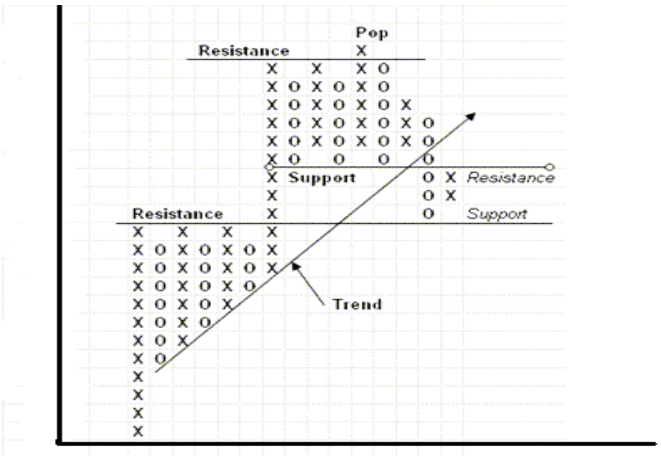

FIGURE 7: POINT AND FIGURE CHART

The above are some of the charts that can be used for analyzing the currency and drawing future conclusions for the same. Apart from these there several other types of charts that can be used to analyze the data systematically such as price scaling in which there are two methods called as arithmetic method and logarithmic method. Charting is can be of very useful for various investors too who speculates currencies and bears a high degree of risk.

Conclusion

Though there are different types of charting techniques but it is not necessary that one method is better or the other is better. Both can be put to use as and when required. Every method has its own advantages and drawbacks attached to it. Forecasting with the help of this method and by the use of these charts becomes comparatively easily as compared to fundamental models. The choice

of whether which chart to use depends upon the analyst and the type of information and the output he looks for. Once the methodology is selected the analyst should stick to the method in order to read the coming signals and find the correlation between the past and the current trend and predict future currency or asset values. The key to successful charting analysis is 'dedication' towards knowledge and development, 'focus' toward the use of methodology and 'consistency' in maintain charts and studying them regularly.

2.3.2.2. Moving average

This is also one of the popular models in conducting technical analysis. In this method the prices of currencies or any other financial asset will show small auto correlation. It is more commonly used with time series data. The key feature of this technical analysis method is that it analyses short term fluctuations and highlights long term trends. The parameters will automatically be set through short term autocorrelations and long term trends can be predicted. This model waits for the asset to show some significant changes and then it reacts upon them. The main purpose of moving averages is smooth variable changes in the assets price in order to signal major trends. Moving averages is nothing but an average of past price of asset. They are classified into short term moving average and long term moving average. If there are most recent past prices then it is called as short run moving average (SRMA) and if there is long series of past data we call it as long run moving average (LRMA). There is also called as double moving averages where both, long run and short run moving average is used. LRMA always gives a small importance to recent changes and thus it

always lags SRMA. In this moving average model, buys and sell signal are triggered when SRMA of past rates crosses a LRMA. For example, if a currency is moving downward, its SRMA will be below its LRMA. When it starts rising again, it soon crosses its LRMA, generating a buy signal. “Mathematically, a moving average is a type of convolution and so it is also similar to the low-pass filter used in signal processing. When used with non-time series data, a moving average simply acts as a generic smoothing operation without any specific connection to time, although typically some kind of ordering is implied” (Wikipedia). There can be various types of moving averages such as simple moving average, cumulative moving average and weighted moving average. Now let us see briefly how each one of these moving average types can help in predicting future short term movements based on the past trends.

Simple moving average

Simple moving average (SMA) is average of any security over a specific period of time such as 20 days, 30, 50, 100 or 200 days. It is used to create charts and these charts conclude whether the security is trending upward or downward. Simple moving average can be used on to keep tracks on daily weekly and monthly patterns. It can also be defined as “ an unweighted mean of previous n data points”. (http://en.wikipedia.org/wiki/Moving_average)

For example, a 50-day SMA of closing price is the mean of previous 50 days closing prices. Hence the formula is given as:

$$SMA = \frac{p_M + p_{M-1} + ...p_{M-49}}{50}$$

Where p_M , p_{M-1}, .. p_{M-49} are the prices of the security.

Moreover, new numbers can be added on daily, weekly or monthly basis and the old numbers are dropped out. This can be expressed in the form of eqution as:

$$SMA_{Today} = SMA_{Yesterday} - \frac{p_{M-n}}{n} + \frac{p_M}{n}$$

This above equation helps in analyzing and giving out successive values where the new number is added every time and the old number is dropped out.

Cumulative Moving Average

Cumulative moving average is just a different version of a same model. In this method prices are calculated using the unweighted average of the data assembled in ordered data stream. It is a sequence of the i values $CA_i = \frac{x_1 + ...+ x_i}{i}$. When new value is added the old value is dropped out the equation becomes:

$$CA_{i+1} = \frac{x_{i+1} + iCA_i}{i+1}$$

where CA can be equal to zero

Weighted Moving Average

The term weighted denotes some specific multiplier. The same logic applies to the moving average as well; weighted average is an average calculus that has multiplying factors assigned to give different weights to different data points. In technical analysis each and every weight of a weighted moving average carries some specific and unique weight and every weight decreases arithmetically. The last data point is 'n' so the second last data point will be denoted by (n-1) and so on. It can be calculated as follows:

$$WMA_M = \frac{np_M + (n-1)p_{M-1} + ... + 2p_{M-n+2} + p_{M-n+1}}{n + (n-1) + ...2 + 1}$$

The above equation helps in estimating the weighted moving average price of the security based on the historical data and future predictions on the same weighted trend can be analyzed.

3. RESEARCH METHODOLOGY

The main purpose of the dissertation is to analyze the inaccuracy of the forecasted exchange rate and the real exchange rates and justify conclusion regarding the same. In order to calculate the errors or in other words, the percentage difference in the actual forecasted exchange rates and the real exchange rates difference, data has been collect mainly from Thomas Reuters (3000 Xtra). Thomas Reuters is a data source containing exchange rate data forecasted by 45 financial institutions across the globe. The main methods used to forecast future exchange rates by these financial institutions are technical analysis and Purchasing power parity (Thomas Reuters). Charting and moving averages are the main methods of technical analysis used by financial institutions in order to forecast short term exchange rates. With respect to purchasing power parity future currencies are calculated using the modern formula in which firstly future interest rates of the respective countries are predicted and then with the help of the spot rate future exchange rate are defined. The formula of PPP to forecast future currencies is given as:

$$\text{Expected Future Spot Rate} = \text{Current Spot Rate} * \frac{(1+\text{Foreign Inflation Rate})}{(1+\text{Home Inflation Rate})}$$

All the data is gathered from secondary data (Thomas Reuters). Exchange rates of developed economies have been selected as a target group and three months future rates have been predicted. United States of America (US$), Japanese Yen (¥), Euro (€) and Great Britain Pound (£) are the targeted currencies that have been used in the analysis. The main purpose of using the exchange rates of the above currencies is that they have been very strong economies in the world. These currencies have always been very sensitive in nature. They have been affected by the smallest as well as biggest financial and non financial factor in the world. Japan is one of the fastest growing economies where as US dollar, Euro have the highest supply of currencies in the world market and United Kingdom pound is one of the strongest currencies of the world. The data range used in the research is from 30th November 2007 to 1st December 2009 but comparison of actual real data and forecasted data is made only till 1st September 2009. Rest data range from 2nd September to 1st December is the forecasted data analyzed in Thomas Reuters by over 45 financial institutions across the globe using technical and fundamental methods of forecasting. The graphs in Appendix 1, Appendix 2, Appendix 3 and Appendix 4 shows the trend comparison of the actual exchange rates and the forecasted exchange rates of *Euro (€)/Us Dollar ($), Pound (£)/US Dollar ($), Yen (¥)/Pound (£), Yen (¥)/US Dollar ($)* respectively. The pink line extra pink line of the mean shows the future forecasted exchange rates. The main reasons to analyze the data range of this period are because this period includes the start of crises, the main crises period and now the recovery of crises period. Hence, this analysis will help in

understanding how different currencies can respond in different situation. For this purpose daily forecasted highs and lows (Max-Min) are calculated which is how high or low can an exchange rate between two countries can fluctuate. Median which is (N+1)/2 and Mean which is the total of the observation divided by the number of observation are also calculated. The actual values are then compared with the mean values and error term [(Actual value-Mean value)/Mean value*100] is found. This error term now shows the percentage difference between the actual data and the forecasted data. Negative errors denotes over valuation of currencies where as positive errors denote undervaluation. Now let's analyze the errors and state some the financial and the non financial reason which causes these errors.

'z' TEST ON THE DATA COLLECTED

There are many statistical tests that can be performed in order to interpret errors such as 't' test, 'F' test but since the population is normally distributed and the number of observations are more than 50 (n>50) I found 'z' test the most appropriate for such kind of data. The test statistic used with the z test is called as 'z' statistic and it is given as:

$$\text{z-statistic} = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

where:

$\bar{x} =$ Sample Mean

$\mu =$ Hypothesized population Mean

$\sigma =$ Standard deviation of the population

$n =$ Sample Size

Since we have to check whether the forecasted data are accurate at certain significance level we considering a two tailed hypothesis test at 5% significance level where:

Ho= The difference between the forecasted data and the actual data is equal to zero ($\mu = 0$)

H1= The difference between the forecasted data and the actual data is not equal to zero ($\mu \neq 0$)

Let us now consider all the four cross currencies (Euro/US Dollar, Pound/US Dollar, Pound/Yen, US Dollar/Yen) and see whether the forecasted data are accurate or not at 5% significance level by performing this z test on them. In order to conclude whether the forecasted data are accurate or not we will compare the z statistics with the critical values and if the z statistics value is less than the critical value we will reject the null hypothesis and conclude that there exists some errors i.e there is some difference between the forecasted value and the actual value and visa-versa.

VOLATILITY AND DATA AVERAGE'S

VOLATILITIES

Volatility means the rate at which the security moves up and down. Here for a set of appox 460 observations for all the four exchange rates volatilities have also been calculated in order to analyze the actual rates, the forecasted rate and the errors more deeply. Volatility in actual exchange rate data and volatility in errors have been calculated in order to see what percentage change (security movement) has been identified every day in the actual exchange rate data and in the errors. Moreover these volatility number will also help the investors in future Option calculations and hedging their future currency risk. Volatility in actual exchange rate data has been calculated by using the formula: (Current Date Exchange Rate-Previous Date Exchange Rate)/(Previous Date Exchange Rate)*100, where as volatility in errors is calculated by: (Current Date Error-Previous Date Error)/(Previous Date Error)*100. Basically it is Difference/Base *100. Since volatility in errors doesn't make much of the sense we only try to interpret the daily movements in the actual exchange rate that is volatility in actual.

AVERAGE'S

Averages are calculated by taking the sum of the observations and dividing it by the no. of observations.

4. ACCURACY OF CURRENCY FORECASTING

4.1 Data Analyses

The world's four main currencies namely; the US dollar, the Euro, Japanese Yen and the Great Britain pound have always been unique, special, in demand since the start of floating rate regime. Each of these currencies has its own history of fluctuations due to several financial and non financial reasons. In this highly sensitive foreign exchange market it has been very difficult task for various economists, financial institutions, other investors and forecasters to accurately forecast future exchange rates. Regardless of using the best possible methods (technical and fundamental) huge errors have been reported and huge losses have been incurred. The below following tables shows the date, the actual and the forecasted exchange rate (mean) data and the error (undervaluation and overvaluation) of the following four exchange rates:

Euro (€)/Us Dollar ($)

Errors

If we look at the recent history of euro and US dollar, since the beginning of 2007 there was devaluation in the US dollar as against the euro due to interest rate deductions by US Federal reserves. In the start of 2008 euro again appreciated upto 1.60/$ and in the later end of the year in again tremendously depreciated upto 1.2457/$ and then again euro appreciated upto 1.33/$ in March 2009. Now let us analyze the errors caused during this period.

Exchange rate	Date	Actual rate	Forecasted Rate (Mean)	Error % (+/-)
Euro/US Dollar	27/10/2008	1.2466	1.5480	**-19.47**
	20/11/2008	1.2457	1.5420	**-19.21**
	12/11/2008	1.2469	1.5420	**-19.13**
	11/11/2008	1.2517	1.5420	**-18.82**

Table 2: Euro (€)/Us Dollar ($)

The above table shows the top four errors of the Euro/dollar exchange rate from a data range of 520 observations. The highest error has been observed on 27th of September 2008 which is 19.47%. This means the actual rate was 19.47% undervalued from the actual forecasted (mean) data. The above table can also be interpreted as; the euro depreciated 19.47% as against US dollar if compared with its forecasted value. If noticed the entire top four errors were caused in between the month from October 2008 end and November 2008 end. There can be several reasons that have let to these errors which will be covered later in the study.

AVERAGE AND VOLATILITY IN ACTUALS

The overall average of error of Euro/Dollar for 458 observations is 6.51% which simply means for a collected time frame of 458 days there exist an average of 6.5% inaccuracy between the forecasted data and the actual data. Apart from

this when we see the volatility of the actual exchange rate data of Euro/Dollar (Appendix 1, Blue line) we can see that they are huge volatile. The later half of 2008 was the highest volatile in the collected sample. There was a price change of 3.79% in a single day recorded on 17th of March 2009 as compared to the standard deviation of 0.96%. Moreover, when we compare the volatilities (price movement) of the forecasted data and the actual data, we can observe that Euro /Dollar actual exchange rate was more volatile as compare to the forecasted rate causing huge errors between them.

INTERPRETATION OF THE 'z' TEST PERFORMED ON THE DATA COLLECTED

Let us now first check whether the collected forecasted samples (458 observations) of Euro/US Dollar are accurate or not. The average of the sample mean of the for 458 observation ($\bar{x}$) is 1.4266, the hypothesized value (μ) is 0, the average of the standard deviation of the errors (σ) is 0.1125 and the sample size (n) is 458.

$$\text{'z'-statistic} = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

Substituting the values in the above equation we get our z statistic value as +**0.60**. Now if we compare our z value with the critical value at 5% significance level which is ±1.96, 10% significance level which is ±1.65 and 1% significance level which is ±2.58 for a two tail test in the normal distribution table our z value < z critical value for all the three significance level hence, we reject our null

hypothesis and conclude that there exist some difference (errors) between the forecasted data and the actual data at 5%, 10% and 1% significance level.

Pound (£)/US Dollar ($)

Error

These are the two world's strongest currencies having the most impact on the world economies. The UK pound reported a 26 year old high on November 7, 2007 which is $2.1161/£ and the reported a 24 year low on 1st January 2009 which is $1.35/£.

Exchange rate	Date	Actual rate	Forecasted Rate (Mean)	Error % (+/-)
Pound/US Dollar	11/20/2008	1.4727	1.933	**-23.81**
	11/14/2008	1.4751	1.933	**-23.68**
	12/3/2008	1.477	1.933	**-23.59**
	11/13/2008	1.4863	1.933	**-23.10**

TABLE 3: Pound (£)/US Dollar ($)

The above table shows that pound depreciated against the US dollar mainly in the last two months of the 2008 year. The actual rate was again undervalued as against the forecasted values. The main reason was the huge impact of recession on the UK economy. The highest error reported on 20th November 2008 followed by 14/11/2008, 3/12/2008 and 11/13/2008.

AVERAGE AND VOLATILITY OF ERROR

The average error of Pound/Dollar for 457 observations is **7.70%.** Apart from this when we see the volatility of the actual exchange rate data of Pound/Dollar (Appendix 2, Blue line) we can see that they are also huge volatile. As seen in Appendix 2 huge movements in price started from second half of 2008 and it continued till the end of the collected data. There was a price change of **3.85%** in a single day recorded on **19th Jan 2009** as compared to the standard deviation of **0.90%.** Moreover, when we compare the volatilities (price movement) of the forecasted data and the actual data, we can observe that Pound/Dollar actual exchange rate was more volatile as compare to the forecasted rate causing huge errors between them.

INTERPRETATION OF THE 'z' TEST PERFORMED ON THE DATA COLLECTED

For Pound/Dollar, the average of the sample mean for 457 observation ($\bar{x}$) is 1.739, the hypothesized value (μ) is 0, the average of the standard deviation of the errors (σ) is 0.17 and the sample size (n) is 457.

$$\text{'z'-statistic} = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

After substituting the values in the above equation we get our z statistic value as **+0.48.** Now if we compare our z value with the critical value at 5% significance level which is ±1.96, 10% significance level which is ±1.65 and 1% significance

level which is ±2.58 for a two tail test in the normal distribution table our z value < z critical value for all the three significance level hence, we reject our null hypothesis and conclude that there exist some difference (errors) between the forecasted data and the actual data at 5%, 10% and 1% significance level.

Yen (¥)/Pound (£)

Error

Japanese yen is the only currency which benefited from the crises. This was mainly because of high repatriation of Japan's extensive foreign investments. (http://www.economywatch.com/exchange-rate/euro.html). The below diagram says it all.

Exchange rate	Date	Actual rate	Forecasted Rate (Mean)	Error % (+/-)
Yen/Pound	1/23/2009	122.62	183.8	**-33.28**
	12/30/2008	130.3	195.3	**-33.28**
	1/22/2009	123	183.8	**-33.07**
	12/3/2008	137.89	205.7	**-32.96**

TABLE 4: Yen (¥)/Pound (£)

The above table of Yen/Pound exchange rate shows the inaccuracy of forecasted data called as errors. Percentage wise this exchange rate has reported the highest error which is upto 33.28% undervalued. This all mainly happen due to surprising demand for the Japanese yen in the world. There are

other several reasons stated in the study which also contributed in these huge errors.

AVERAGE AND VOLATILITY OF ERRORS

The average error of Pound/Yen for 458 observations is **11.50%.** Apart from this when we see the volatility of the actual exchange rate data of Pound/Yen (Appendix 3, Blue line) we can see that they are huge volatile. The major dip in this exchange rate was in the last quarter of 2008. There was a price change of **9.11%** in a single day recorded on **27th Oct 2008** as compared to the standard deviation of **1.40%.** Moreover, when we compare the volatilities (price movement) of the forecasted data and the actual data, we can observe that Pound/Yen actual exchange rate was more volatile as compare to the forecasted rate causing huge errors between them.

INTERPRETATION OF THE 'z' TEST PERFORMED ON THE DATA COLLECTED

For Pound/Yen the average of the sample mean of the for 457 observation ($\bar{x}$) is 176.70, the hypothesized value (μ) is 0, the average of the standard deviation of the errors (σ) is 25.40 and the sample size (n) is 457.

$$\text{'z'-statistic} = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

Substituting the values in the above equation we get our z statistic value as **+0.33**. Now if we compare our z value with the critical value at 5% significance level which is ±1.96, 10% significance level which is ±1.65 and 1% significance

level which is ±2.58 for a two tail test in the normal distribution table our z value < z critical value for all the three significance level hence, we reject our null hypothesis and conclude that there exist some difference (errors) between the forecasted data and the actual data at 5%, 10% and 1% significance level.

Yen (¥)/US Dollar ($)

Error

As compared to Yen/pound exchange rate there was comparatively low percentage errors caused in the yen/dollar exchange rates. But 1 thing was common in all of these four exchange rate that all the major four errors in the past two years from end of 2007 to end of 2009 were caused during the peak recession time which was during the end 2008.

Exchange rate	Date	Actual rate	Forecasted Rate (Mean)	Error % (+/-)
Yen/US Dollar	12/17/2008	87.31	108.6	**-19.60**
	12/16/2008	88.93	108.6	**-18.11**
	12/19/2008	89.12	108.6	**-17.93**
	12/18/2008	89.38	108.6	**-17.69**

TABLE 5: Yen (¥)/US Dollar ($)

AVERAGE AND VOLATILITY OF ERRORS

The average error of Pound/Yen for 458 observations is **6.18%.** Compare to all this exchange rate has been very less volatile. But there was a price change of **6.41%** in a single day recorded on **27th Oct 2008** as compared to the standard

deviation of **0.97%.** Moreover, when we compare the volatilities (price movement) of the forecasted data and the actual data, we can observe that Dollar/Yen actual exchange rate was more volatile as compare to the forecasted rate causing huge errors between them.

INTERPRETATION OF THE 'z' TEST PERFORMED ON THE DATA COLLECTED

Let us now first check whether the collected forecasted samples (457 observations) of Euro/US Dollar are accurate or not. The average of the sample mean for 457 observation ($\bar{x}$) is 100.94, the hypothesized value (μ) is 0, the average of the standard deviation of the errors (σ) is 7.18 and the sample size (n) is 457.

$$\text{'z'-statistic} = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

Substituting the values in the above equation we get our z statistic value as +**0.66**. Now if we compare our z value with the critical value at 5% significance level which is $\pm$1.96, 10% significance level which is $\pm$1.65 and 1% significance level which is $\pm$2.58 for a two tail test in the normal distribution table our z value < z critical value for all the three significance level hence, we reject our null hypothesis and conclude that there exist some difference (errors) between the forecasted data and the actual data at 5%, 10% and 1% significance level.

Now let us study some of the reasons influencing and causing the above errors.

4.2 REASONS FOR THE INACCURATE FORECASTING

4.2.1 Financial Reasons

Inflation

This is the most important financial factor directly affecting the exchange rates of any country. The value of money is determined by the supply and demand. The central bank of any country can dominate the money supply by selling or buying government bonds. There are many factors affecting the demand of money one of them is the average level of prices. The demand of money is affected by various factors of which the average level of prices in the economy is considered to be one of the most important factors. Nonetheless, in the long run, price level would get adjusted to the level that balances the demand and supply (Mankiw, 2004). Inflation is introduced with an increase in the money supply as the value of money is determined by the amount of money available in the economy, and the growth in the amount of money is the primary cause of inflation. In case of excess supply of money, people use the excess money in order to buy goods and services. This excess money could also be used to make deposit in the bank that will further allow other people to borrow money for buying goods and service or could also be used to buy a bond. Both of these outcomes would result in the increase in demand for goods and services. As the demand rise, so does the price level and in turn a rise in the money demand further resulting in a new equilibrium with higher price level when the demand and supply is balanced (Mankiw, 2004). The rise in inflation would result in a rise in interest rate following

the Fisher effect. However in the case of short run when the inflation is unanticipated, this might not hold (Mankiw, 2004). PPP has been defined as a flow model of the inflation theory of exchange rates by Hoontrakul (1999). The theory relies on the law of one price assuming a risk-neutral world where the market is integrated and very competitive. According to the theory, same quantity of goods can be bought in all the countries with any given currency (Mankiw, 2004). If this is not the case, then there would be occasions where in profits are left unexploited. PPP in rating the model as one of the most vulnerable approaches in explaining the exchange rate movement has been supported by Montiel (2003). However later he observed that many stationary tests on real exchange rates had rejected the PPP model. An argument regarding the deviation of exchange rate from the level predicted by PPP in the short run had been put forth by Madura (2006). PPP is no longer a corner stone for modeling has also been explained by Dornbusch (1986). He also explains that the attention has shifted and turned to modeling changes in equilibrium relative prices. The PPP model remains controversial. However PPP continues to appear accurate in the long run and it is usually used as a benchmark currency valuation since, if there is a structural change in the national productivity it would result in a permanent change in real exchange rates. A shift in technology, tastes, commercial policies, or policy growth could cause this structural change (Hoontrakul, 1999). Finding the equilibrium period is another limitation of PPP model (Madura, 2006). When the model is tested, there is variation in the results with the base period used. Thus the period must be chosen in a way that it

reflects the equilibrium period since subsequent period are evaluated in comparison to it. Thus choosing an appropriate based period for testing PPP is a difficult task for economists.

Interest rate

One of the important variables in forecasting of foreign exchange rate is interest rates. Interest rates illustrate the impact on savings and investment which further explains the relationship between the present and future economy, thus interest rates become a crucial variable and macroeconomists need to be aware of them (Mankiw, 2004). Fisher effect puts forth the relationship between nominal interest rates, real interest rates and inflation rates. There is a relationship between interst rate and exchange rate which can be explained with the help of PPP which states that there exists a relationship between inflation rates and exchange rates (Hoontrakul, 1999). Under the assumptions stated for perfect capital mobility and perfect capital substitutability, interest rate parity hold many supporting evidences. However consistent risk premium over time might prevail due to different monetary policy, degree of risk aversion, political risks, barriers to capital mobility, and market microstructure variations (Hoontrakul, 1999). Even though a major application of IRP is the pricing model for forward rates, political risk and market invention, apart from liquidity preferences has emerged as one major implication for Thailand. These risks were reflected through the money markets and forwards markets. Madura (2006) puts forth his argument with the support of the various academic studies done in the past which conducted empirical examination on IRP in finding out the relationship between forward rate

premium and interest rate differentials, that it generally supports IRP. However, difficulties have been encountered in determining conclusively whether IRP holds, as it is crucial to compare the interest rate and the forward rate quotation that are crop up at the same time. Economists are prevented from obtaining the quotations that reflect the same point in time due to barriers like the limitation of access to data. Thus, the results could be distorted when both quotations do not represent the same time of the day.

Income level

Exchange rate helps in determining the comparison of income level. Ramcharran (2000) states that, the fact that income rate is highly affected by the level of exchange rates in some way is reflected in the results of empirical regression. Exchange rates are affected by income level in some way has been explained by Madura (2006). Income level causes variation in the number of imports demanded. Expectation of higher interest rates is sometimes caused by higher income level. Further on, financial inflows may be attracted and may also overcome unfavorable trade flows. Thus, results if higher income level could range from greater imports to greater inflow of funds which may further strengthen the local currency.

4.2.2 Non-Financial Reasons

Although all risks are not financial, they do have an impact on the finance of any country. The various non- financial factors that affect an economy which in turn might have an impact on various exchange rates across the globe are as follows:

Political Risk

Political stability plays an important role as it directly affects the sensitive financial markets. Various investors, economists, banks and other financial institutions engaged in forecasting activities should consider this non-financial factor. Assessment of political risk can be done at two levels, namely, Micro-level and Macro-level. Micro-level risk involves Firm-specific risk and Macro-level risk involves Country-specific risk and Global-specific Risk. Firm specific risks do not impact much on the financial markets but Country-specific risk and Global-specific Risk do have impact on the financial markets.

Global-specific risk: this type of risk has come to the forefront in the recent past. This covers various factors under it like_*Terrorism and War*: Terrorism is growing at a very fast pace. In the past we have experienced attacks by terrorist list the 9/11 and 26/11/2008 and also suffered its aftermath. These attacks had tremendous effects on the exchange markets as the maximum high errors were just before and after that period.

Economic Factors

These include economic policy, disseminated by government agencies and central banks, and economic conditions, generally revealed through economic reports. Economic policies include fiscal policy and monetary policy. These economic factors have a large impact on the fundamental approach in exchange rate determination. Decisions made regarding spending practices and budget like taxation and government spending are stated herein. Monetary policies would give an in depth idea of the level of interest rate affecting supply and cost of money. Whereas economic conditions would throw light on inflation level and trends, along with economic growth and health. These all factors contribute to the inaccuracy of exchange rate forecasting.

International Taxation

Taxation also plays a major role today as it directly affects countries GDP. If the tax policies are not properly maintain on global bases it might affect the exchange rates between two countries. Also it must understand the multinational taxation and constraints on profit repatriation.

Economic Crises (Recession)

The various economic crises like the subprime crises, the oil crises can also lead to the high fluctuations in exchange rates the subprime crises which started in US in 2006 have give out various drawbacks which are borne until now. The sensitive foreign exchange market can also be affected through any multinational

company's bankruptcy like Lehman Brothers which had a huge impact on foreign exchange market.

5. CONCLUSION

5.1 Summary

In this challenging and competitive market various analysts, investors and speculative traders' needs tools in order to analyze and make take appropriate decisions in order to forecast future exchange rate movements. Hence, the whole thesis was divided into two parts where the first part states models in exchange rate determination where as the later half of the dissertation comments upon the accuracy and inaccuracy of forecasting currencies by comparing the actual exchange rate values and the forecasted exchange rate values so that various users can evaluate future risk and take appropriate decisions. The first half is divided into two parts namely the fundamental approach and secondly the technical approach. Fundamental approach in determining exchange rates includes main parameters such as interest rates, inflation rates, countries GDP, and economic growth in order to forecast future rate movements. Let us see how these parameters can help in determining exchange rates with this fundamental approach. Purchasing power parity is one of the most important and the simplest form of fundamental model of exchange rate determination. It is be divided into two types absolute PPP and relative PPP where absolute PPP is based on the law of one price with several assumptions and a deviation of exchange rates from absolute PPP is relative PPP. Both of these types are rejected in the short run but sometime relative PPP holds in the long run. The second model explained in the thesis is the Balance of Payment flow model. This model is also

divided into two types: firstly Balance of trade model and secondly Balance of payments model. Exchange rates can be determined by finding the equilibrium in the trade balances in both the countries this is called balance of trade model. And when capital account adjustments are done in this balance of trade equilibrium it is called as balance of Payment flow model. Next comes the Mundell Fleming model which is the extension of closed IS-LM model of exchange rate determination. In addition to this also considers the balance of payment equilibrium, money market equilibrium goods market equilibrium and internal monetary market equilibrium. The M-F model also states that the levels of exchange rates are perfectly correlated with monetary policy and monetary supply levels. It further states that devaluation in any currency will lead to further devaluation if BOP and fiscal policies are not maintained properly. Monetary model shows how various different monetary policies impact directly in the exchange rate movements. Exchange rates exchange rates are determined in a broad general equilibrium framework where not only the supplies of and demands for national monies are important but the supply of and the demand for goods and securities are important as well. Lastly, the real exchange rate differential model which is a reduced form Dornbusch model also is an appropriate method in determining exchange rate. According to Michael Rosenberg, real interest rate differential model is based on the following two assumptions: Firstly is assumed that uncovered interest parity holds and secondly the real exchange rates will adjust gradually to its long run purchasing power parity level. The formulae in calculating the rate differential between the

domestic and the foreign country is given as: $q_n^e = n(r - r^*)$. The second section of first half of the thesis includes the technical approach which is classified into two parts which is charting and moving averages. These are the short term methods of forecasting exchange rates. These methods are mainly based on the historical prices and based on that these two models predict future price trends. The later half of the thesis compares the actual exchange rates and the forecasted exchange rates by 45 financial institutions across the globe (Thomas Reuters). The world's most recognized exchange rates namely, yen/US dollar, US dollar/pound, Euro/US dollar, yen/pound are analyzed. The differences in the actual rate and the forecasted the i.e the reasons for the undervaluation and overvaluation have also been analyzed. The below table shows a small overview of the errors prevailing in all the four exchange rates.

Exchange rate	Date	Actual rate	Forecasted Rate (Mean)	Error % (+/-)
Euro/US Dollar	27/10/2008	1.2466	1.5480	**-19.47**
Pound/US dollar	2/12/2008	1.4905	1.933	**-22.89**
Pound/Yen	23/1/2009	122.62	183.80	**-33.28**
Dollar/Yen	17/12/2008	87.31	108.60	**-19.60**

TABLE 6: SUMMERY OF HIGHEST ERRORS

As seen in the above table the highest error is shown in the Pound/Yen exchange rate which is 33.28% as yen surprisingly appreciated during the crises. There are some other financial and non financial factors such as inflation rates,

interest rates, economic factors, political risk and international taxation that have contributed to these errors.

Implication of size of errors for financial decision making

Traders, investment banks, financial institutions, analysts, companies and various private individuals predict the future movement of the financial markets before making any investment decisions. Hence, these historical errors and high volatility price movements will help the above mentioned users in several ways. Various users and financial institutions can hedge their future currency risk not only by using the forecasted values generated by various models but also taking into consideration the errors that can be caused. Apart from hedgers, various cross currency arbitragers can also perform arbitrage if there exists huge volatility and errors in individual currencies. These historical price volatility and errors can also be used by various economist in improving forecasting models and find parameters which are ignored in the models i.e parameters from which errors are caused.

5.2 Limitations

The most important limitation is that, it was very difficult to know any individual financial institution's forecasted exchange rates. Though approached around 10 financial institutions (Barclays Capital, RBS, ICICI securities etc) engaged in forecasting activities 8 of them didn't bother to reply back. According to the response given by the two banks, methodology and models used in order to forecast exchange rates are very secretive information which according to them cannot be disclosed. Secondly the forecasted data which is forecasted by 45 financial institutions it was very difficult to know which financial institution have

disclosed what information. I am not sure whether the fundamental models explained in the dissertation are still used to determine long term exchange rates. Information on every subtopic in each of the fundamental models were not easily available. Hence, it was very difficult to express everything own my own. Moreover, with regard to the fundamental models it was very difficult to express the derivations in own words hence might be a bit difficult to understand for a lay man. Empirical evidence of fundamental approach to exchange rate determination was difficult to find hence some of the models itself included empirical evidences. Lastly could not write much on this topic as more deep in this topic would have complicated the dissertation more.

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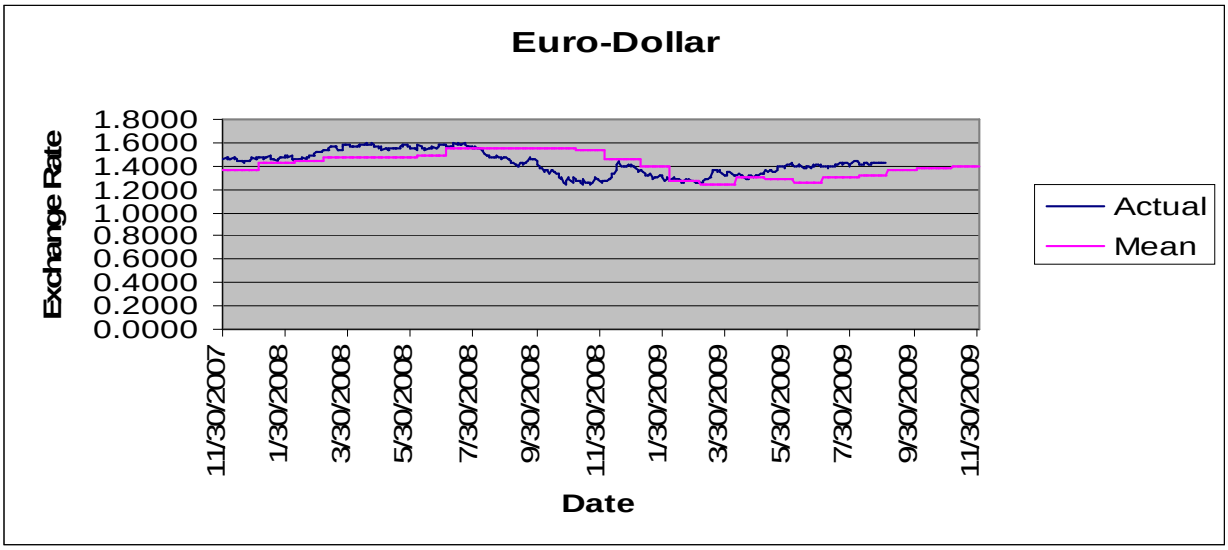
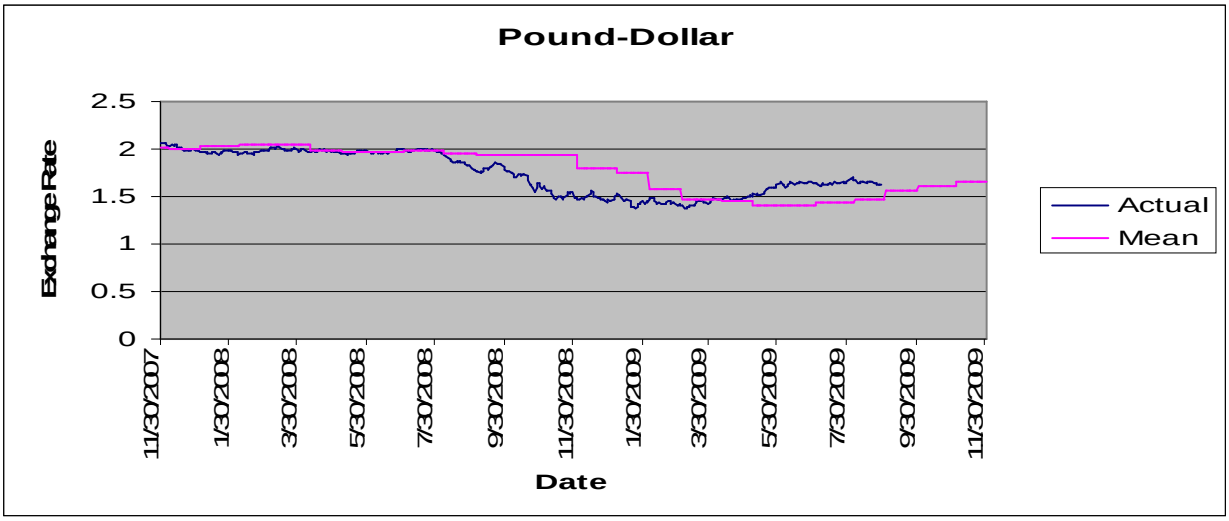
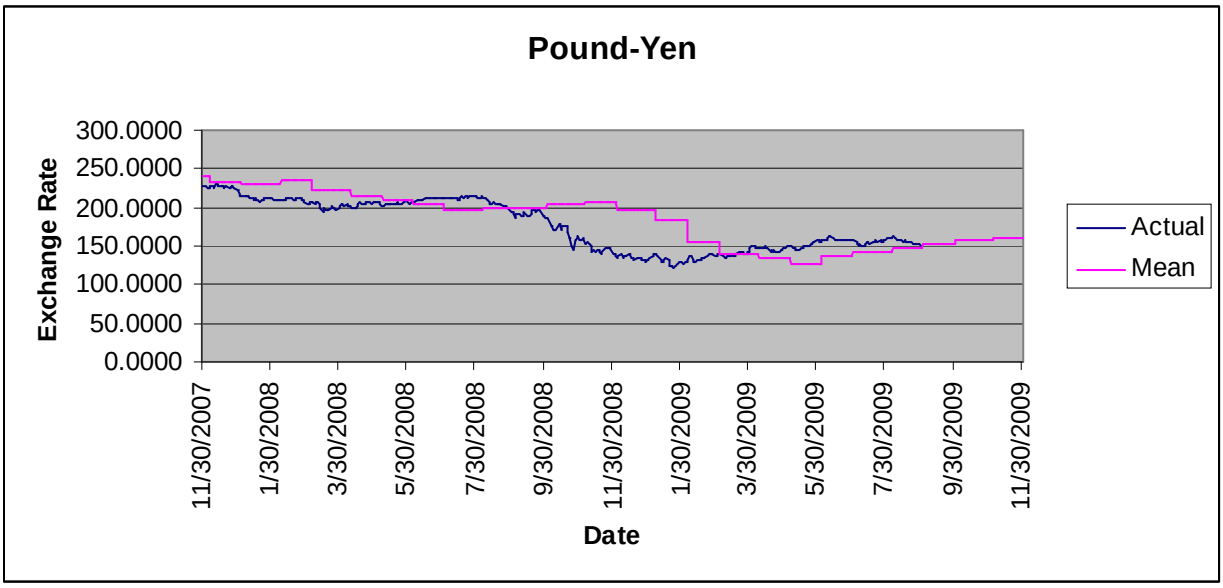
APPENDIX 1



APPENDIX 2



APPENDIX 3



APPENDIX 4